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(54) **Nonwoven materials made from fine decitex cardable polyolefin fibers.**

(57) The fabrics of this invention have a unique combination of liquid barrier properties and high air permeability and comprise at least one carded nonwoven web comprising at least 10% by weight, based on the total weight of cardable fibers, of cardable polyolefin fibers having a fiber fineness of 0.5 to 1.2 decitex. Preferably the polyolefin fibers have a hydrophobic surface, and the nonwoven material is thermally consolidated. Laminates comprising at least one layer of the fabrics of this invention and at least one layer of another nonwoven material are also disclosed.

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This invention relates to nonwoven materials made from polyolefin fibers, and to laminates incorporating these materials.

Nonwoven web structures are generally produced using three basic processes: (1) spunbonding, where continuous filaments are extruded and deposited on a screen to form a continuous nonwoven structure; (2) meltblowing, where the extruded polymer melt is stretched, broken into short fibers, blown by a jet of heated air, and deposited on a belt to form the nonwoven structure; and (3) carding, where staple fibers are separated by a carding machine and laid out in a nonwoven web structure.

Nonwoven materials are commonly used in the manufacture of protective garments such as those worn by medical personnel, clean room personnel, and farm workers. For example, U.S. Patent 5,108,827 discloses a thermally-bonded nonwoven fabric that is made from a web comprising 100 to 5 weight percent multiconstituent fibers. The fibers are made from a dispersion of two or more polymers that can be melt spun into fibers and then formed into webs, e.g., by carding, airlaying, or wetlaying. Biconstituent staple fibers made from a blend of ethylene/l-octene and polypropylene can be used.

Nonwoven materials to be used in the manufacture of such protective garments have two essential requirements: liquid barrier properties, and comfort to the wearer. Most of the liquid barrier fabrics currently available exhibit very low air permeability, causing heat build-up and therefore heat stress for the garment wearer. Some currently available fabrics such as spunbonded materials provide adequate air flow, but lack the required liquid barrier properties. There is a need for a nonwoven material that exhibits a combination of impermeability to liquids and high air permeability.

The fabrics of this invention comprise at least one carded nonwoven web which is characterized in that the carded nonwoven web comprises at least 10% by weight, based on the total weight of cardable fibers, of cardable polyolefin staple fibers having a fiber fineness of 0.5 to 1.2 decitex. Preferably the polyolefin fibers have a hydrophobic surface, and the nonwoven material is thermally bonded. The fabric preferably has a liquid strike-through resistance (mm of H_2O) of at least 150 millimeters and an air permeability of at least 100 cubic feet per minute.

Also according to the invention, the cardable polyolefin fibers having the specified fiber fineness can be blended with other cardable fibers, including polyolefin fibers having a fiber fineness greater than or less than 0.5 to 1.2 decitex, and cardable fibers other than polyolefin fibers.

Also according to the invention, the fabrics of this invention can be combined in a laminate structure with webs of other nonwoven materials, including webs made from polyolefin fibers having a different fiber fineness, webs made from cardable fibers other than polyolefin fibers, and webs made from noncardable fibers. The fabrics of this invention can also be combined with polymer films, preferably breathable polyethylene or polypropylene films.

The fabrics of this invention and laminates comprising at least one layer of the fabrics of this invention in combination with another nonwoven material provide a unique combination of good liquid barrier properties and high air permeability.

The fabrics of this invention comprise at least one carded nonwoven web comprising at least 10%, preferably at least 20%, and most preferably at least 40% cardable polyolefin staple fibers having a fiber fineness of 0.5 to 1.2 decitex. Preferably the cardable polyolefin fibers have a fiber fineness of 0.7 to 1.2 decitex, most preferably 0.8 to 1.0 decitex. Decitex is the weight in grams of 10,000 meters of each fiber. The staple fibers are preferably 1 to 6 inches long, more preferably 1 to 3 inches, and most preferably 1-1/4 to 2 inches long.

The polyolefin staple fibers suitable for use in this invention can be splittable or fibrillated and preferably have a hydrophobic surface. The polyolefin fibers can be made from either linear or branched polyolefins. Suitable cardable polyolefin fibers include polypropylene fibers, including atactic, syndiotactic and isotactic polypropylenes; polyethylene fibers, including low density, high density and linear low density polyethylenes, and fibers made from copolymers of 1-olefins such as, for example, ethylene, propylene, butene, octene, and hexene, e.g., a copolymer of ethylene and propylene. Preferred polyolefin fibers are polypropylene fibers having a hydrophobic surface. If multicomponent sheath/core fibers are used, the fibers preferably have the polyolefin in the sheath. The core can be a polyolefin or another polymer such as, for example, a polyamide or polyester. The preferred multicomponent fibers are sheath/core bicomponent fibers.

The fabrics can be made entirely from cardable polyolefin staple fibers having a fiber fineness of 0.5 to 1.2 decitex, or these polyolefin fibers can be blended with other cardable fibers, including polyolefin fibers having a fiber fineness greater than or less than 0.5 to 1.2 decitex, and cardable fibers other than polyolefin fibers. The fibers should preferably be uniformly dispersed during the blending process in order to maintain the desired combination of impermeability to liquids and high air permeability. The other cardable fibers can be multicomponent or multiconstituent fibers. Examples of multicomponent fibers are sheath/core and side-by-side fibers, where each component of the fiber is spun from a single polymer. Multiconstituent fibers are spun from a polymer melt that is a blend of polymers. If the other cardable fibers are not hydrophobic, they

should preferably be treated to make them hydrophobic.

The other cardable fibers used in the blends can include hydrophilic fibers with fluorocarbon surface finishes, or fibers with fluorocarbons added to the melt from which the fiber was spun as described by Thompson et al., Tappi Journal, May 1992, pages 124-134. Alternatively, the fabrics made from blends of cardable polyolefin fibers and hydrophilic fibers can be post-treated with fluorocarbons. Suitable hydrophilic fibers include, for example, polyamide, polyester, rayon, and cellulosic fibers. A fluorocarbon is defined as a compound of carbon and fluorine, with or without hydrogen, analogous to a hydrocarbon in which all or nearly all of the hydrogen has been replaced by fluorine. Suitable fluorocarbon surface finishes include SCOTCHGUARD® FC, available from Minnesota Mining & Manufacturing Co., St. Paul, MN. Suitable fluorocarbon additives for the polymer melt include, for example, FX 1801 fluorocarbon additive available from Minnesota Mining & Manufacturing Co., St. Paul, Minnesota.

The cardable polyolefin staple fibers used in the preparation of the fabrics of this invention can be treated with a surface finish comprising an antistatic agent and a lubricant. Polyolefin fibers with such a finish are described, for example, in U.S. Patent 4,938,832, where the surface finish comprises a neutralized phosphoric acid ester and a polysiloxane.

Fibers useful in the practice of this invention are described, for example, in U.S. Patent 5,281,378 and published European Patent Applications 486,158; 516,412; 557,024 and 552,013.

The fabrics of this invention comprising at least one carded nonwoven web comprising at least 10% by weight of cardable polyolefin staple fibers having a fiber fineness of 0.5 to 1.2 decitex preferably have a liquid strike-through resistance (mm of H_2O) of at least 150 millimeters, most preferably at least 200 millimeters. These materials preferably also have an air permeability of at least 80 cubic feet per minute (40.6 $cm^3/cm^2/sec$), most preferably at least 100 cubic feet per minute (50.8 $cm^3/cm^2/sec$). The basis weight of the fabrics is preferably 10 to 100 g/m^2.

In the manufacture of the fabrics of this invention, the cardable fibers are carded using a series of sequentially arranged carding machines. The carded webs from the various machines are deposited on top of each other on a moving belt to form a layered web structure. This layered web structure is "the fabric of this invention" referred to in this specification.

The fabric of this invention can also be combined with one or more layers of other nonwoven materials such as webs of cardable polyolefin fibers having a fiber fineness greater than or less than 0.5 to 1.2 decitex; webs of cardable fibers other than polyolefin fibers; webs of noncardable fibers such as spunbonded, meltblown or hydroentangled webs, or with one or more layers of film, preferably breathable films. Other cardable fibers include, for example, polyamide, polyester, rayon and cotton fibers. If the other nonwoven material is not hydrophobic, it should preferably be treated to make it hydrophobic. Suitable films include, for example, polyethylene, polypropylene, polyester, and breathable polyethylene and polypropylene films. The other nonwoven material or film can be combined with the thermally bonded fabrics of this invention, or the fabrics of this invention can be combined with the other nonwoven materials or film before thermal bonding.

Any of these nonwoven materials can be consolidated to improve fabric strength using any one or a combination of techniques such as, for example, calender thermal bonding, through-air bonding, hydroentangling, needle-punching, ultrasonic bonding, and latex bonding.

Laminates comprising at least one layer of a fabric comprising at least one carded nonwoven web comprising at least 10% cardable polyolefin fibers having a fiber fineness of 0.5 to 1.2 decitex combined with at least one layer of another nonwoven material preferably have a liquid strike-through resistance (mm H_2O) of at least 150 millimeters, most preferably at least 200 millimeters. These laminates also preferably have an air permeability of at least 80 cubic feet per minute, most preferably at least 100 cubic feet per minute.

The fabrics of this invention can be used in any applications where a combination of good liquid barrier properties and high air permeability are required, e.g., filtration media, medical and clean room garments, CSR wrap, and absorbent article backsheets. They are particularly useful for protective clothing.

The liquid strike-through resistance (mm H_2O) of the fabrics of this invention is determined using a rising water column height test. This test subjects one side of a fabric to increasing water pressure, as indicated by the height of the distilled water column, until water droplets are observed on the other side of the fabric. The higher the height of the water column (pressure), the better the fabric's water barrier properties.

The procedure used for this test is as follows. A 10 cm x 10 cm fabric sample was mounted at the bottom of a transparent graduated cylinder having an inside diameter of 3.8 cm. Filtered demineralized water was pumped just above the fabric surface at the rate of 4.8 ml/second (an increase in water column height of 4.2 millimeters/second). The other side of the test fabric was observed for the first signs of water penetration. As soon as the first sign of water penetration was observed (indicated by a drop of water), the water column height was recorded. This procedure was repeated for five replicate samples. The average water column height for these five replicates represents the rising water column test value of the test fabric.

The air permeability of the fabric was measured using the ASTM D737-75 test procedure. The air permeability was measured in cubic feet per minute (CFM)/ft^2 against an air pressure drop of 0.5 inches (12.7 mm) of water across the fabric sample. Air permeability can also be expressed as cm^3/cm^2/sec by multiplying the CFM value by 0.508.

The grab strength of the fabrics was measured using the ASTM D1682-64 test procedure.

The web or fabric basis weight is the weight in grams of one square meter of web or fabric.

The fiber fineness is expressed in terms of decitex. Decitex is defined as the weight in grams of a 10,000 meter length of a fiber. A lower decitex (dtex) value indicates a finer fiber. The fiber decitex can be determined either by direct weight measurement or by indirect means such as calculations based on the cross-sectional area of the fiber and the fiber density.

The polypropylene fibers used in the examples were hydrophobic Type 190, Type 195, and Type 211 fibers available from Hercules Incorporated, Wilmington, DE. The pigmented fibers, as denoted by color, contained normal amounts of pigments as used in the art, i.e., up to 5% based on the total weight of the fibers.

Example 1

Nonwoven webs were produced by using a series of sequentially arranged carding machines that were supplied with polypropylene hydrophobic staple fibers (Types 190, 195, and 211) having a cut length of 3.8 cm and with the fineness indicated in the following table. These staple fibers were carded by the carding machines, and carded webs were deposited on top of each other on the moving belt to form a layered web structure for in-line thermal consolidation at a line speed of 23 to 30 meters/minute. The basis weight of individual webs was varied as indicated in the tables to make composite structures. The thermal consolidation was carried out by using heated calender rolls with a point pattern and a total bond area of 15%. The temperature of the calender rolls is also indicated. The decitex (dtex) and the percent of the total weight of fibers supplied to each carding machine are given in Table 1. The letter designation after the dtex value indicates the color of the fiber: W - white; B - blue; G - green; Y - yellow. The 2.4 decitex white fibers (2.4W) were Type 190 fibers; 0.8 decitex white fibers (0.8W) were Type 195 fibers, and other fibers in the following table were Type 211 fibers. These hydrophobic fibers had surface finishes comprising a mixture of 50% polydimethylsiloxane available from OSi Specialties, Inc., Danbury, CT as grade Y12, 411 and 50% LUROL® AS-Y neutralized phosphate esters available from G.A. Goulston Co., Monroe, NC.

TABLE 1

	Carding Machine Number								Total Fabric Basis Weight	Bonding Temp.	Grab Strength Properties				Water Column Height	Air Flow Rate
	1		2		3		4				Cross Direction		Machine Direction			
Sample	dtex	%	dtex	%	dtex	%	dtex	%	(g/m²)	(°C)	Strength (g)	Elong. (%)	Strength (%)	Elong. (%)	(mm)	cm³/cm²/sec
A Control	2.4W	25	2.4W	50	-	-	2.4W	25	38	157	2700	120	7900	70	118	238
B Control	2.4W	25	2.4W	50	-	-	2.4W	25	47	157	3800	160	10000	80	100	172
C	2.4W	17	0.8W	33	0.8W	33	2.4W	17	38	157	1600	70	6800	30	204	119
D	2.4W	30	0.8W	20	0.8W	20	2.4W	30	38	157	2100	80	7500	40	171	157
E	2.4W	25	0.8W	25	0.8W	25	2.4W	25	49	157	2200	70	7900	40	211	101
F	2.4W	13	0.8W	37	0.8W	37	2.4W	13	46	157	1900	70	7100	30	211	101
G	1.7B	17	0.9B	33	0.9B	33	1.7B	17	35	155	2600	90	10000	40	205	109
H	1.7B	25	0.9B	25	0.9B	25	1.7B	25	46	157	3000	90	12700	40	245	79
I	1.7B	22	0.9B	28	0.9B	28	1.7B	22	51	158	3800	100	16300	40	235	60
J	1.7B	25	0.9B	25	0.9B	25	1.7B	25	55	156	4400	100	15900	40	267	61
K	1.7W	17	1.0G	33	1.0G	33	1.7W	17	48	157	3500	110	13600	50	154	80
L	1.7W	17	1.0Y	33	1.0Y	33	1.7W	17	48	157	3500	110	12700	50	223	75
M	(50%/50% Fiber Blend of 1.7B/0.9B to each carding)								49	157	2600	100	11800	40	209	84
N	(100% 0.9B to each machine)								49	157	2300	70	10700	30	260	64
SMS (Kimberly-Clark Corporation); Basis Wt. = 40 g/m²															300	30
SONTARA (DuPont); Basis Wt. = 52 g/m²															185	23

SMS is a nonwoven spun-bonded/melt blown/spun-bonded polypropylene composite fabric, available from Kimberly-Clark Corporation, Roswell, GA. SONTARA is a spunlaced polyester/wood pulp nonwoven fabric, available from Du Pont, Wilmington, DE.

Samples A and B are controls, and Samples C through N are examples of this invention. The data show the unique combination of improved water barrier properties and good air permeability obtained for the fabrics

of this invention. Table 1 also indicates that the currently available commercial fabrics SMS and SONTARA exhibit low air permeability, even though they have good liquid barrier properties.

Example 2

Nonwoven webs were produced by using a series of sequentially arranged carding machines as described in Example 1. The carding machines were supplied with polypropylene hydrophobic staple fibers Type 211 (available from Hercules Incorporated, Wilmington, DE) with differing or similar fineness as indicated in Table 2. The staple fibers were carded by the carding machine and carded webs were deposited on top of each other on a moving belt to form a layered web structure for inline thermal consolidation at a line speed of 13.7 meters/minute. The basis weight of individual webs was varied as indicated in Table 3 to make composite structures. In some samples a finish-free polypropylene spun-bonded fabric with 14 g/m^2 basis weight from American Nonwovens, Inc., Vernon, Alabama, USA, was incorporated prior to calender bonding. Samples O and R contained the spunbonded fabric at the bottom of the combined carded webs from carding machines 1 through 4 and in sample P the spunbonded fabric was fed between carding machines 2 and 3, thereby sandwiching the spunbonded fabric between two sets of the carded webs of this invention. Thermal bonding was carried out by using heated calendar rolls with a point pattern with a total bond area of 15%. The temperatures of the calender rolls are also indicated in Table 2. The first temperature is the temperature of the top calender and the second temperature is the temperature of the bottom calender. The decitex (dtex) and the percent of the total weight of staple fibers supplied to each carding machine are given in Table 2. The letter designation after the dtex indicates the color of the fiber: W-white; B-blue; G-green; Y-yellow. These hydrophobic fibers had the surface finish described in Example 1 comprising a mixture of polydimethylsiloxane and neutralized phosphate esters.

TABLE 2

Sample	Carding Machine Number 1 dtex	1 %	2 dtex	2 %	3 dtex	3 %	4 dtex	4 %	Total Fabric Basis Weight	Bonding Temp.	Grab Strength Properties: Cross Direction Strength	Cross Direction Elong.	Machine Direction Strength	Machine Direction Elong.	Water Column Height	Air Flow Rate
									(g/m²)	(°C)	(g)	(%)	(%)	(%)	(mm)	cm³/cm²/sec
O	(50%/50% Fiber blend of 1.7B/0.9B to each carding machine)								52[1]	150/150	6800	69	15900	40	183	63
P	(50%/50% Fiber blend of 1.7B/0.9B to each carding machine)								44[2]	140/151	4500	59	11400	39	162	54
Q	0.9B	25	1.7B	25	1.7B	25	0.9B	25	33	140/151	3200	68	9500	31	169	85
R	0.9B	25	1.7B	25	1.7B	25	0.9B	25	53[1]	140/151	5900	68	13200	40	203	51

[1] - Including spunbonded fabric at the bottom.
[2] - Including spunbonded fabric in the middle.

The data show the unique combination of improved water barrier properties and good air permeability obtained for the fabrics of this invention, and for laminates comprising the fabrics of this invention combined with a layer of spunbonded fabric.

It is not intended that the examples given here should be construed to limit the invention, but rather they are submitted to illustrate some of the specific embodiments of the invention. Various modifications and va-

riations of the present invention can be made without departing from the scope of the appended claims.

Claims

1. A fabric comprising at least one carded nonwoven web characterized in that the carded nonwoven web comprises at least 10% by weight, based on the total weight of cardable fibers, of cardable polyolefin staple fibers having a fiber fineness of 0.5 to 1.2 decitex.

2. The fabric of claim 1, further characterized in that the polyolefin fibers have a hydrophobic surface.

3. The fabric of claims 1 or 2, further characterized in that the fabric is thermally consolidated.

4. The fabric of any of the preceding claims, further characterized in that the liquid strike-through resistance (mm of H_2O) of the fabric is at least 150 millimeters and the air permeability is at least 80 cubic feet per minute.

5. The fabric of any of the preceding claims, further characterized in that the cardable polyolefin staple fibers are homogeneously blended with other cardable fibers.

6. The fabric of claims 1 to 5, further characterized in that the polyolefin fibers are multicomponent fibers.

7. Use of the fabric of any of the preceding claims to make a laminate, characterized in that the laminate comprises at least one layer of the fabric and at least one layer of another nonwoven material.

8. The use of claim 7, further characterized in that the other nonwoven material comprises cardable fibers selected from the group consisting of polyamide, polyester, rayon, and cotton fibers.

9. The use of claim 7, further characterized in that the other nonwoven material comprises non-cardable fibers.

10. The use of claims 7 to 9, further characterized in that the laminate is thermally consolidated.

11. Use of the fabric of any of claims 1 to 6 to make a laminate characterized in that the laminate comprises at least one layer of the fabric of claim 1, and at least one layer of a film.

12. The use of claim 11, further characterized in that the film is a breathable polyethylene or polypropylene film.

13. The use of claims 11 and 12, further characterized in that the laminate is thermally consolidated.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 2383

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X A	EP-A-0 296 572 (HERCULES) * the whole document *	1 2,3,5,10	D04H1/42
X A	US-A-4 868 031 (JAMES P.MODRAK) * the whole document *	1 2,3,5,9,10	
A	EP-A-0 516 412 (HERCULES) * abstract; claims *	2	
A	EP-A-0 367 989 (HERCULES) * claims; examples *	4,8	
A	EP-A-0 486 158 (HERCULES) * abstract; claims *	1,2,5	
A,D	US-A-5 108 827 (SCOTT L.GESSNER) * the whole document *	1-10	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)
D04H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 July 1994	Durand, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ABSTRACT:

CHG DATE=19990617 STATUS=O> The fabrics of this

invention have a unique combination of liquid barrier properties and high air permeability and comprise at least one carded nonwoven web comprising at least 10% by weight, based on the total weight of cardable fibers, of cardable polyolefin fibers having a fiber fineness of 0.5 to 1.2 decitex. Preferably the polyolefin fibers have a hydrophobic surface, and the nonwoven material is thermally consolidated. Laminates comprising at least one layer of the fabrics of this invention and at least one layer of another nonwoven material are also disclosed.